Northwest Journal of Teacher Education

Volume 2
Issue 1 *Northwest Passage: Journal of Educational Practices*

Article 1

January 2002

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Recommended Citation

Armstrong, Terry; Kennedy, Teresa J.; and Coggins, Porter (2002) "Summarizing Concepts About Teacher Education, Learning and Neuroscience," *Northwest Journal of Teacher Education*: Vol. 2 : Iss. 1 , Article 1.
DOI: https://doi.org/10.15760/nwjte.2002.2.1.1

Summarizing Concepts About Teacher Education, Learning and Neuroscience



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ABSTRACT

Despite on-going reform, teacher education today is virtually unchanged from models used in the 1920's. The achievements of the past century however have been remarkable in every way. Neuroscience records and the human genome project hold the prospect of truly expanded conceptualizations for teacher educators. This article summarizes concepts relating to the human cerebrum that speak to individual uniqueness derived from neuroscience research of the past several decades. Five areas of investigation are noted that could provide the theoretical underpinning for teacher education collaboration with neuroscientists. Neuroscience theorists are identified in anticipation that their work may provide insights to teacher educators. Is it time to advance a new teacher education component?

A listing of all of the variables affecting achievement in our schools would show that the "playing fields" among school districts are truly uneven. This fact has long been troubling for teacher educators. Our list would reveal that the variety of facilities, funding, equipment, enrichment opportunities, leadership, teacher quality, class size, library, community mental health, property values, and a hundred other factors affect the quality of local school offerings. Likewise, the frequency of single parent homes, out-of-wedlock births, unwanted pregnancies, inadequate pre-natal care, poverty, teen and youth violence, drug and alcohol consumption, crime, and dropout rates also affect the nature of the community/school environment. The extent to which affected children are found in classrooms produces conditions that teachers obviously find difficult. Preparing aspiring teachers about accommodating these diverse learners is one of teacher educations most serious challenges.

Although citizens criticize public schools and today's youth, evidence suggests that many students are performing quite well. One could simply look at the physical accomplishments of today's young athletes to clearly see this illustrated. High school track records for every state eclipse Olympic records of six decades back. Moreover, the numbers of students inducted into national honor societies and those who qualify for national scholarships are increasing each year. Interestingly though, a comparison of a contemporary high school biology book with one published in 1947 also shows some remarkable differences:

1947 text	Contemporary text
Text weight 1 lbs.	6 lbs.
Text pages 565 total	1243 total
References to genetics 7 pages	403 pages
References to apples 22 pages	0 pages
Reference to genes 1 page	220 pages

This list could continue. The fact that the school year has not increased while the salient fund of information has, creates significant issues for both teachers and students. The growth in knowledge is another confounding issue for teacher educators.

In 1947 it was generally believed that students could be placed on a continuum that formed a bell-shaped curve. That is to say some were slow to learn, some fast and the majority were in the middle. It was said that learning was aptitude dependent. If students were normally distributed on the bell-curve and all received the same instruction, their grades or achievement, would also be normally distributed. Later, it was realized that if student aptitude is normally distributed but the kind and quality of teaching is designed to fit the characteristics of each learner, then every student should achieve mastery of the subject. It followed that all students could learn if given adjusted amounts of time. Today's schools focus on mastery of a set of standard objectives gained through individual student effort when provided with learning approaches appropriate to each student. Effort rather than aptitude is the key to academic success (Shalock & Smith, 1997). Are teacher educators striving for effort-based objectives?

Learned societies, state departments of education and local school persons are presently working hard to ensure that a standards based curriculum is available to all students. Achievement of the standards is the focus for current school legislation and improvement. We will have to look to the future to learn if and how this movement has changed current educational outcomes.

Throughout the past centuries, decisions about schooling have been based on experiences of teachers. Teachers teach the way they were taught and the way they learned. We are now entering a new era where learning may be based on knowledge about how brains create themselves through experience along with individual genetic instructions. The list below summarizes concepts from the past twenty years that relate to how one component of the brain, the anterior cerebral hemispheres, have the potential to process information differently:

1. Intellectually and experientially, humans are more different than alike – a factor associated with our continued evolution.

2. Mental potential is being reached through exposure to an enriched environment pre/post birth.

3. The cerebral cortex is responsible for conscious thought, action, movement and sensation.

4. The cerebral cortex is organized in independent modules that work, in parallel and are laterally specialized.

5. The cerebral cortex matures in stages but left/right hemispheres differ in function.

6. Elevated fetal testosterone during the first trimester may cause the cerebral cortex to grow asymmetrically.

7. Since modularities may be affected by fetal testosterone concentrations there may be either reductions or additions to modularity size on either hemisphere.

8. In-utero/cortical growth occurs via young cortical pyramidal cells migrating on glial strings from the inner layer of the fluid filled center of the brain – the ventricles.

9. The size and combination of modularities gives an individual his/her unique mental potential. Varied experiences then continue to create the brain throughout life.

10. The eight intelligences of Howard Gardner may be modularity specific.

11. The permutations and combinations of modularity type and size are infinite as are the number of experiences one could have.

12. Within each of the eight multiple intelligence modularities there are numerous submodularities.

13. Modularities, working in parallel, influence intellectual abilities and inabilities. Modularities may be observed through a variety of imaging systems.

14. The two hemispheres are connected through axonal links at the central corpus callosum.

15. There is a direct correspondence left to right/front to back in connections through the corpus callosum.

16. The various parts of the brain communicate by way of neurochemicals.

17. Neurochemicals must be synthesized each day through appropriate diet.

18. Neurochemicals are made of 22 amino acids – 11 from sugar and 11 via proline, valine, tyrosine, tryptephan, isoleucine, methionine, threonine, histadine, alanine, lysine, and leucine.

19. It's not how smart you are – but rather how you are smart (Gardner, 1993).

It would be interesting to speculate about what our world would be if all brains were identical. Even though this is an odd idea, we often find discussions about teaching that assume the idea of identical brains. More important is what factors contribute to brain uniqueness? What factors account for individual differences? As with any energizing new idea, there are numerous theories – each of which has supporters and detractors while all relate to brain variability. The list includes:

1. Cerebral laterality. First trimester insults to the mother that cause changes in the amount of cortical tissue on the right and left cerebra. Norman Geschwind's complicated theory cites both deficits and giftedness that may occur through elevated fetal testosterone levels (Geschwind & Galaburda, 1987; McManus & Bryden, 1991).

2. Genetic variability. With the advent of the sequencing of the human genome, we recognize that modularity size, neurochemical synthesis and inherited attributes all stem from genetic influence (Claverie, 2001).

3. Neurotransmitters. During the past twenty years the chemical nature of nerve cell communication has been clarified. Many neurochemicals derive from dietary protein that must be included in daily consumption and over 100 such compounds have been described. An insufficiency or too much of a chemical can cause behavioral imbalance.

4. Experience. It has been demonstrated that enriched experiences enhance neural growth and thus enhanced learning. Brains construct themselves through life experiences. The more stimulation the greater the learning (Diamond, 1998).

5. Development. The line graph below illustrates brain growth in relation to the alternating stages of body growth. Although the brain is not fully functional until ages 23-29, some variation in growth may influence learning (Thatcher, 1991; Hudspeth & Pribrum, 1990).

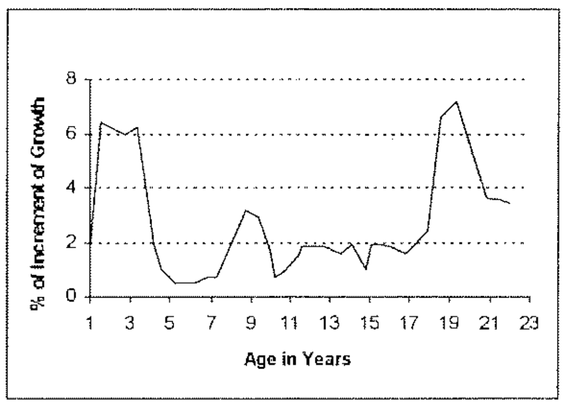

Figure 1. Brain growth in relation to the alternating stages of body growth. (Chart modified from Hudspeth/Pribram showing growth stages in the frontal cortex).

A review of neuroscience articles of the past five years in the journal of the American Association for the Advancement of Science suggests that the ideas presented above are holding true. The publication, Science, is published weekly and is held in high regard. Interestingly, the U.S. Department of Education is not supporting much neuroscience research. The National Institutes of Health appear to be the responsible agency for education related studies including reading. The fact that the U. S. Department of Education is slow to support neuroscience creates a vacuum in needed research and communication of information. The association for Supervision and Curriculum Development (ASCD) is much more in tune with current neuroscience thinking, support, and education (Brandt, 1998).

Highly able students are said to be conceptually complex or high in conceptual level (Hunt, 1971). A lot of work has examined the extent to which the corpus callosum links the modularities on either side of the cerebral cortex. One theorist, Michael Gazzanaga (1989; 2000), implies that the corpus callosum provides the clue to high conceptual level individuals. The Gazzanaga team has noted that each hemisphere has specialized functions but the corpus callosum allows these developments to be integrated into a constant functional system. Our work at the University of Idaho utilizing measurement calculations developed by Sandra Witelson (1990) suggested that the anterior and posterior pieces of the corpus callosum are larger in gifted children when compared with "normal" controls. This may be attributable to either more axonal strands found in the larger sections of the corpus callosum connecting the two hemispheres or greater myelination (Coggins, 2002).

When will teacher education researchers begin to associate with their neuroscience colleagues? Leda Cosmides and John Tooby (1994) have suggested that cognitive psychologists align themselves with neuroscience to form a more rigorous discipline void of intuition. They assert that one of the more primitive brains, the limbic system, needs to be more fully studied so that we may better understand our adaptive selves. Although we no longer hunt, gather, or worry about detecting predators, those brain functions are still with us. Elsewhere we have written about the potential of a standards-driven limbic curriculum (Armstrong, 2001; 2002). Since anatomic form follows function, we should carefully examine those structural designs on the basis of how they seek to solve adaptive problems. With this view in mind, a more satisfactory education system might develop.

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Web sites of interest

http://oscar.ed.uidaho.edu/brain

http://ivc.uidaho.edu/flbrain

http://www.BrainConnection.com

http://www.newhorizons.org

http://www.beemnet.com/dana

http://www.iamyourchild.org

http://www.cnbc.cmu.edu (technical)

http://www.pzweb.harvard.edu (multiple intelligences)

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